Our Reference: SLN-104-A PATENT

VARIABLE LOW INTENSITY INFRARED HEATER

FIELD OF THE INVENTION

[0001] This invention relates to an apparatus and method for heating an enclosed space with a variable ~~high~~low intensity infrared heater.

BACKGROUND OF THE INVENTION

[0002] Gas fired infrared heaters typically are used in large industrial settings. A gas heater burns natural gas, propane, or similar combustible gases and the combustion by-products or exhaust gases are passed through a radiant heating tube which becomes hot and radiates energy waves therefrom. Reflectors are often used to reflect the energy waves toward the desired location usually toward the floor where the infrared energy waves are converted into heat. These low intensity infrared heaters generally operate at full capacity when not in an off condition with the result that the burner constantly cycles between its on condition and its off condition, thus making it difficult to control heating levels.

[0003] There have been some attempts to create a two-stage heater by utilizing a single gas flow control assembly with two pressure settings with a single speed blower. The problem with this system is that even though the gas pressure, and therefore the gas volume, is varied between the two stages, the blower speed is constant. As a result at both high and low stages the volume of air is the same. Therefore there is either too much air for a low stage or too little air for the high stage resulting in low efficiency combustion. Practically, since these systems idle most of the time at low stage, the excess air results in low efficiency operation and a great amount of wasted energy. Further, since a single gas flow control assembly valve is utilized, it is difficult to achieve an accurate setting for either the high or low level operation.

SUMMARY OF THE INVENTION

[0004] This invention is directed to the provision of improved, more efficient radiant heater.

[0005] The radiant heater of the invention is of the type including a burner having an inlet for receiving an air and gas mixture and an exhaust for emitting exhaust gases generated by combustion of the air and gas mixture within the burner; an elongated radiant heating tube having an inlet for receiving the exhaust gases emitted by the burner; a gas valve for controlling the flow of gas to the burner; and a blower for controlling the flow of air to the burner. According to the invention, the blower comprises a two-stage blower having a low speed for delivering a low air flow to the burner and a high speed for delivering a high air flow to the burner. This arrangement allows for a proper and fixed air/gas ratio for both ~~high and low stage~~high- and low-stage operation of the burner.

[0006] According to a further feature of the invention, the blower includes an electric motor having a low winding corresponding to the blower low speed and a high winding corresponding to the blower high speed. This arrangement provides a ready and efficient means of providing the two levels of blower operation.

[0007] According to a further feature of the invention, the gas flow control assembly includes a ~~two regulator~~two-regulator assembly or a ~~two valve assembly~~two-valve assembly, each having a different setting, one a low setting for delivering a low gas flow to the burner and the other having a high setting for delivering a high gas flow to the burner. This arrangement, utilizing a ~~two stage~~two-stage blower in combination with a ~~two stage~~two-stage gas flow control assembly, allows for precise control of the desired air/gas ratio for both ~~high and low level~~high- and low-level operation.

[0008] According to a further feature of the invention, the valve assembly includes two valves for independently controlling gas flow from a source to the burner. This arrangement allows for precise control of the gas flow volumes provided in the high and low level operational stages.

[0009] The invention also provides a method of heating a room with an infrared heater of the type including a burner having an inlet for receiving an air and gas

mixture and an exhaust for emitting exhaust gases generated by combustion within the burner; and an elongated radiant heating tube having an inlet for receiving the exhaust gases emitted by the burner.

[0010] According to the invention methodology, a ~~two stage~~two-stage gas valve is provided having a low setting for delivering a low gas flow to the burner and a high setting for delivering a high gas flow to the ~~burner; a~~burner. A two stage blower is provided having a low speed for delivering a low air flow to the burner and a high speed for delivering a high air flow to the burner; and the blower is operated at the low speed when the gas flow control assembly is operating at the low setting and at the high speed when the regulator is operating at the high setting. This methodology allows precise air/gas ratios to be provided at both the ~~high and low level~~high- and low-level operational stages of the burner.

[0011] According to a further feature of the invention methodology, a temperature set point is defined for the ~~room;~~room, a programmed temperature differential is ~~defined;~~defined, the temperature of the room is ~~monitored;~~monitored, and the burner is ignited when the room temperature is less than the temperature set ~~point; a~~point. A temperature threshold is defined as the temperature set point minus the temperature ~~differential; the~~differential. The blower is operated at the high level when the room temperature is equal to or below the temperature ~~threshold;~~threshold, and the blower is operated at the low level when the room temperature is greater than the temperature threshold and lower than the set point temperature. This arrangement provides a ready and convenient means of providing high level operation when the room is relatively cold relative to the set point temperature and providing low level operations when the room temperature is close to the set point temperature.

[0012] According to a further feature of the invention methodology, the regulator is a ~~two stage~~two-stage regulator and the method includes the further step of operating the regulator at a high level when the blower is operating at the high level and operating the regulator at a low level when the blower is operating at the low level. This methodology allows precise air/gas ratios to be provided at both the high and low level operational stages of the burner.

[0013] According to a further feature of the invention methodology the gas flow control assembly has either of two valves or two regulators operating in parallel and the method includes the step of opening one valve or regulator and closing one valve or regulator when the regulator is operating at the low level and opening both valves or regulators when the gas flow control assembly is operating at the high level. It is understood that also one valve or regulator could provide a higher flow such that one valve or regulator is used for the low setting and the other for a high setting. This methodology allows for precise control of the volume of gas delivered at both the low level and the high level operational stages.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The description herein makes reference to the accompanying drawings wherein like reference numerals refer to like parts throughout the several views, and wherein:

[0015] Figure 1 is a perspective view of a radiant heater according to the invention;

[0016] Figure 2 is a cross section of the heater schematically showing reflected energy waves;

[0017] Figure 3 is a side elevational view of the heater;

[0018] Figure 4 is a fragmentary, cross-sectional, somewhat schematic view of the heater;

[0019] Figure 5 is a cross-sectional view taken on line 5-5 of Figure 4;

[0020] Figure 6 is a detail cross-sectional view of a gas flow control assembly utilized in the heater;

[0021] Figure 6A is a detail cross-sectional view of an alternate gas flow control assembly utilized in the heater; and

[0022] Figure 7 is a flow chart showing the operation of the heater.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0023] The infrared heater 10 of the invention, broadly considered, includes a housing 12, a radiant tube 14, a reflector 16, a ~~burner18,~~ burner 18 (shown only in Fig.

4), a blower 20, a gas flow control assembly 22, and a controller 24 (shown only in Fig. 3).

[0024] Housing 12 has a box like sheet metal configuration.

[0025] Radiant tube 14 is elongated and includes an inlet end 14a secured to a front wall 12a of housing 12, in communication with a wall aperture ~~12b, and~~12b as shown in detail in Fig. 4. Radiant tube 14 also includes an exhaust end 14b as shown in Fig. 3.

[0026] Reflector 16 has an inverted U configuration in cross-section, is suitably supported in spaced overlying relation to tube 14, and is generally coextensive with tube 14.

[0027] ~~Burner~~As shown in Figs. 4 and 5, burner 18 is elongated and generally tubular, has a venturi configuration, and includes an inlet end 18a positioned in housing 12 proximate wall 12a and an outlet end 18b positioned in the inlet end 14a of tube 14 and centered concentrically within the tube by a plurality of circumferentially spaced spokes or vanes 18c.

[0028] Blower 20 is a centrifugal blower and includes a housing 26 and an electric motor 28 mounted on a side wall ~~26a~~26c of the housing and driving the blower scroll or impeller in a known manner. Housing 26 includes an air inlet 26a and an air exhaust 26b communicating with an aperture 12c in housing rear wall 12d whereby actuation of the blower discharges pressurized air into the interior of the housing 12.

[0029] Motor 28 is a ~~two-speed~~two-speed motor having a high winding and a low winding so that the blower comprises a ~~two-stage~~two-stage blower having a low speed for delivering a low air flow to housing 12 and burner 18 and a high speed for delivering a high air flow to housing 12 and burner 18. Motor 28 may for example comprise a 1/25 HP, 110 V AC single phase 60 hz motor and may be operative to deliver a low air flow of 25 CFH and a high air flow of 50 CFH.

[0030] Gas flow control assembly 22 may be supported within housing 12 on housing lower wall 12e and comprises either a ~~two-stage~~two-stage regulator or a ~~two stage~~two-stage valve with the two stages achieved by the use of two independent

valves 30 and 32 as shown in Figs. 4 and 6 or two regulators 202 and 204 arranged in parallel within a common housing as shown in Fig. 6A.

[0031] Valve 30 includes a gas inlet 30a, a redundant solenoid valve 30b, a main valve 30c controlled by a spring 30d and a diaphragm 30e, a gas outlet 30f, a cap screw 30g, an adjustment screw 30h, and a vent 30i.

[0032] Valve 32 is identical to valve 30 as indicated by the like reference numbers 32a-32i.

[0033] Main valves 30c and 32c are controlled in known manner by solenoids and each valve is moveable between first and second positions corresponding to the valve being 100% closed and 100% open respectively.

[0034] In the assembled burner package shown in Fig. 4, blower 20 is mounted on rear housing wall 12d with the blower outlet 26b aligned with housing wall aperture ~~12c;~~12c. The regulator assembly 22 is mounted on housing lower wall 12e within housing ~~12; a~~12. A gas inlet line 34 passes through housing rear wall 12d and thereafter bifurcates to form a first branch 34a communicating with the inlet 30a of valve 30 and a second branch 34b communicating with the inlet 32a of valve ~~32; branch~~32. Branch gas outlet lines 36a and 36b communicate respectively with the outlet 30f of valve 30 and the outlet 32f of valve 32 and thereafter converge to form gas outlet line 36, which extends within housing 12 to a free end 36c~~which is~~ fixedly and centrally secured to an annular disk 38a positioned at the inlet end 18a of burner 18 and defining a plurality of perforations 38a shown in Fig. 5.

[0035] Controller 24, shown in Fig. 3, may be mounted on housing 12 and is connected by a lead 40 to a ~~two-stage~~two-stage thermostatic probe 42 carried by housing ~~12, whereby to provide~~12. The controller 24 provides a reading of room ~~temperature,~~temperature from the probe 42 to regulator 22 by a lead 44~~,~~ and to the high and low windings of motor 28 of blower 20 by a lead 46.

[0036] With respect to the general overall operation of the heater, gas is supplied to the interior of burner 18 via line 36, and air is supplied to the burner 18 via blower 20 with the air from the blower 20 entering into the interior of the venturi through the perforations 38a for mixture with the ~~gas and further air passing~~gas. Air also passes into tube inlet end 14a outwardly of the venturi for passage through vanes

18c, which act to impart a swirl to the air to facilitate the air/gas mixing. It will be understood that ignition is accomplished in a known manner by a pilotless direct spark utilizing an ignition module (not shown) and that burner operation is monitored and controlled in a known manner by an ignition detection control (not shown).

[0037] The specific operation of the invention heater is best understood with reference to Figure 7. The flow sequence for the invention heater begins by defining a set point temperature T_s and a programmed differential d_t and comparing these values to the room temperature T_r as determined by the thermostatic probe 42 and as recognized by controller 24. This comparison is shown at step 100 in Figure 7. If the room temperature T_r is less than the set point temperature T_s the thermostat calls for heat in step 102. If the room temperature T_r is greater than or equal to the set point temperature T_s the controller will turn the unit off as shown in step 104. Once the thermostat calls for heat in step 102, the controller calculates whether the room temperature T_r is less than or equal to the temperature set point T_s minus the programmed differential d_t, or whether the room temperature T_r is greater than the temperature set point T_s minus the programmed differential d_t. This calculation is shown as step 106.

[0038] If the room temperature T_r is less than or equal to the temperature set point T_s minus the programmed differential d_t, the controller, as shown in step 108, commands a high gas flow rate from the gas regulator by energizing solenoids to move both valves 30c and 32c to their second, ~~fully opened~~fully-opened positions, and commands a high air flow rate from the blower by energizing a relay 109 (shown in Fig. 3) in a sense to power the high winding of blower motor 28. The heater 10 is now in a high output mode as shown in step 110 and then loops back to step 100 to continuously monitor the room temperature T_r relative to the set point temperature T_s.

[0039] If the room temperature T_r is greater than~~or equal to~~ the set point temperature T_s minus the programmed differential d_t in step 106, the controller, as shown in step ~~114,~~112, commands a low gas flow rate from the gas regulator by energizing solenoids to move valve 30c to the second, open position and move valve 32c to the first, closed position, and commands a low air flow rate from the blower by energizing the relay 109 in a sense to power the low winding of the blower motor 28. The heater 10 is now in a low output mode as shown in step 114 and then loops back to step 100 to continuously monitor the room temperature T_r for comparison with the temperature set point T_s. It will be understood that if the heater is initially operated at the high output level, when the room temperature T_r reaches the set point temperature T_s minus the temperature differential d_t, the controller will operate to place the heater in the low output mode by switching the blower motor 28 to the low winding and closing valve 32c. When the room temperature eventually reaches the set point temperature T_s, the controller shuts off the heater and allows the blower to stay on for a few minutes to purge any flue gases left in the system.

[0040] With reference to Figure 6A, another preferred two-stage gas regulator 200 is illustrated. Gas flow control assembly 200 may for example be of the type available from White Rogers of St. Louis, MO sold under the brand name *Two Stage Gemini*. As shown, the gas flow control assembly includes a ~~low-fire~~low-fire regulator 202 and a ~~high-fire~~high-fire regulator 204. ~~Low-fire and high-fire~~Low-fire and high-fire regulators 202 and 204 work in combination with main valve 206 to provide two-stage gas control. The regulator body includes an inlet 208 and associated inlet pressure tap 210 and inlet screen 212. Gas exits the assembly 200 at outlet 214. Outlet 214 includes an associated outlet pressure tap 218 and outlet screen 216. The assembly 200 includes a control gas orifice 220 and associated orifice opening ~~212.~~222. Main valve 206 is biased by diaphragm 224 in a manner known to those of skill in the art. The assembly 200 includes a vent 226 and redundant solenoid 228.

[0041] It is understood by those of skill in the art that the assembly illustrated in Figure 6A could be substituted for the assembly illustrated in Figure 6. In particular, where Figure 6 illustrates an assembly in which valves 30c and 32c

selectively cooperate to provide two levels of gas flow, Figure 6A illustrates an assembly in which ~~low-fire~~low-fire regulator 202 and ~~high-fire~~high-fire regulator 204 operate to deliver two gas flows.

[0042] When the temperature drops below the set point, yet still stays above the set point temperature minus the programmed differential, the low stage of the heater comes back on until the thermostat is satisfied. The system idles around the set point on the low stage, on and off, preventing any overshoot effect with otherwise a high heating inertia. However, if there is a sudden drop in the room temperature for any reason the heater comes on with high stage allowing a fast recovery. [0043]

The invention, by utilizing a ~~two-stage~~two-stage blower and a ~~two-stage~~two-stage gas flow control assembly, allows for a proper and fixed air/gas ratio for both the high and low output levels. This arrangement has the advantages of saving energy by operating with optimum gas/air ratios at all times; saving energy by reducing the temperature overshoots due to the high heat inertia; reducing wear and tear on the components by eliminating unnecessary cycling of the unit on high heat; providing accurate constant rate for each stage due to the two independent valves or regulators; allowing for a higher differential between the two stages due to the independent regulator adjustment; and reducing the cost of the heater by eliminating the need for an expensive, continuously variable blower motor providing a continuously variable blower speed.

[0044] The gas flow control assemblies disclosed in the present embodiments provide a much more accurate ~~two-stage~~two-stage flow control as compared to the gas flow control assemblies of the prior art.

[0045] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiments but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims, which scope is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures as is permitted under the law.